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Authors: Cordeiro, Norbert J., Moyer, David C., Stuart, Simon N., Bates, John M., and Turner, Donald A.

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Clarifying the distributions of Abyssinian Crimsonwing *Cryptospiza salvadorii* and Red-faced Crimsonwing *C. reichenovii* in Tanzania

Norbert J. Cordeiro, David C. Moyer, Simon N. Stuart, John M. Bates & Donald A. Turner

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SUMMARY.—Abyssinian Crimsonwing *Cryptospiza salvadorii* and Red-faced Crimsonwing *C. reichenovii* both occur in Tanzania but their distribution on Mt. Meru and in the Crater Highlands is poorly understood. Similarly, the southernmost record of *C. salvadorii* in Tanzania, in the Uluguru Mountains, is ambiguous. We conducted an in-depth literature review and detailed specimen evaluation of these two taxa and here clarify their ranges in northern Tanzania. We failed to find definitive evidence for the presence of *C. salvadorii* in the Uluguru Mountains.

Abyssinian Crimsonwing *Cryptospiza salvadorii* and Red-faced Crimsonwing *C. reichenovii* occur in Tanzania and a few other countries in sub-Saharan Africa. *C. salvadorii* is found from Ethiopia south to northern Tanzania and eastern Democratic Republic of Congo (Zimmerman *et al.* 1996, Keith 2004, Payne 2010). *C. reichenovii* occurs in East Africa from the Albertine Rift Mountains to the Eastern Arc Mountains, and south to the highlands of Mozambique and Zimbabwe, with disjunct populations in the Cameroon-Nigeria highlands and Bioko, and western Angola (Keith 2004, Payne 2010).

Numerous sources covering East African birds (Mackworth-Praed & Grant 1960, White 1963, Hall & Moreau 1970, Britton 1980, Short *et al.* 1990, Zimmerman *et al.* 1996, Keith 2004) provide the southern limit of the range of *C. salvadorii* as forested areas in northern Tanzania on Mt. Kilimanjaro, Mt. Meru and the Crater Highlands. However, there is a record from the Uluguru Mountains reported by Friedmann & Loveridge (1937) that was later questioned by Stuart & Jensen (1985). Our primary aim here is to evaluate this Uluguru record, and to clarify the distribution of this taxon, as well as that of its congener *C. reichenovii*, in northern Tanzania.

Methods

Information concerning *C. salvadorii* and *C. reichenovii* on Mt. Meru, Mt. Kilimanjaro, the Crater Highlands and adjacent volcanos, and the Uluguru Mountains, was reviewed via the literature and an examination of specimens from Tanzania housed in major collections in Europe and North America. With the exception of a few cases, all of the specimens evaluated and discussed in this paper are listed by museum collection, registration number and collector in the Appendix. Museum acronyms are as follows: FMNH = Field Museum of Natural History, Chicago; MCZ = Museum of Comparative Zoology, Harvard University, Cambridge, MA; NHMUK = Natural History Museum, Tring; YPM = Peabody Museum of Natural History, Yale Univ., New Haven, CT; ZMB = Museum für Naturkunde, Berlin; ZMUK = Zoologisk Museum, Copenhagen. A map is provided to facilitate a coherent understanding of our evaluation of distributional records of these two crimsonwings in Tanzania (Fig. 1).

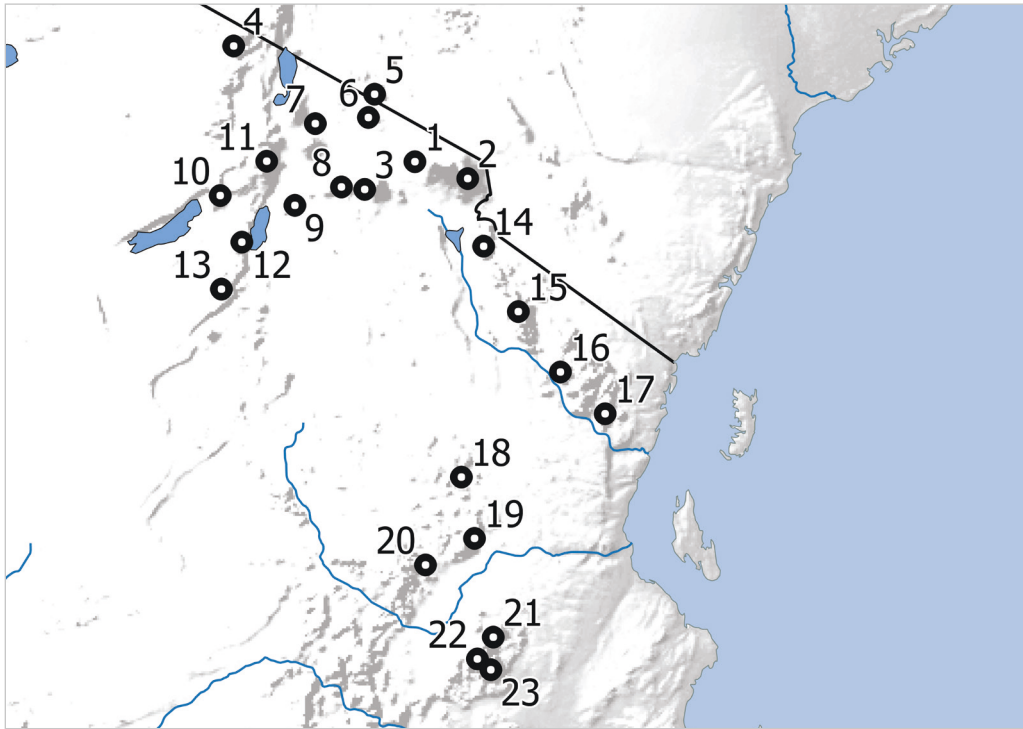


Figure 1. Distributions of Abyssinian Crimsonwing *Cryptospiza salvadorii* and Red-faced Crimsonwing *C. reichenovii* in northern Tanzania and in the Eastern Arc Mountains. Localities as follows: (1) Engare Nairobi, Mt. Kilimanjaro, (2) Mandara, Mt. Kilimanjaro, (3) Olmotoni, Mt. Meru, (4) Loliondo, (5) Ol Doinyo Orok (Kenya), (6) Longido, (7) Kitumbeine, (8) Monduli, (9) Essimingor, (10) Oldeani, (11) Ngorongoro, (12) Marang Forest, (13) Nou Forest, (14) North Pares, (15) South Pares, (16) West Usambaras, (17) East Usambaras, (18) Nguu Mountains, (19) Nguru, (20) Ukagurus, (21) Bagilo, Ulugurus, (22) Tchenzema, Ulugurus, (23) Ukwama, Ulugurus. Two other localities could not be marked due to issues of scale: Mgeta (07°02'S, 37°34'E) and Lukwangule (07°14'S, 37°62'E) are just north and east of Tchenzema, respectively. Map created using QGIS 2.18 (QGIS Development Team (2019) with background layers from <https://www.naturalearthdata.com/>.

Distribution in northern Tanzania

The ranges of *C. salvadorii* and *C. reichenovii* in northern and eastern Tanzania are of interest because their contact zone is purportedly Mt. Kilimanjaro and Mt. Meru (Keith 2004, Payne 2010), but is actually the Crater Highlands as we demonstrate here (Fig. 1). Reports of both *C. salvadorii* and *C. reichenovii* on Mt. Meru are ambiguous. In his annotated list of the birds of Arusha National Park, based on his own records, a small skin collection in the park museum, and notes from D. F. Vesey-FitzGerald, Beesley (1972) reported both *C. salvadorii* and *C. reichenovii* on Mt. Meru. However, he stated 'These two species are treated together, and although none has yet been obtained, I believe their identification is correct.' During his 1905–06 expedition to Mt. Kilimanjaro and Mt. Meru, Sjöstedt (1908) recorded *C. salvadorii* only on Mt. Meru, at 3,500 m. Moreau & Sclater (1935) also reported *C. salvadorii* on Mt. Meru, based on two male specimens from c.1,700 m at Ngare Olmotoni (= Olmotoni: Fig. 1; Appendix). They also reported the first record of the species on Mt. Kilimanjaro, in the west at Ngare Nairobi (c.1,750 m), and in the south at 'Bismarck Hill' (= Mandara, c.2,700 m; Fig. 1; Appendix) (Moreau & Sclater 1935). There is also a 2009 specimen of *C. salvadorii* from Mt. Meru in FMNH (Appendix). Finally, a specimen listed in VertNet.org as *C. reichenovii* from Mt. Meru at YPM (leg. G. Heinrich) is in fact an adult female *C. salvadorii*

(1,800 m, 21 June 1962; Appendix). There are no confirmed reports of *C. reichenovii* on Mt. Meru, and the report of this species in Keith (2004) might reflect Beesley's (1972) statement. Regarding Mt. Kilimanjaro, dated specimens as well as mist-netted birds all confirm *C. salvadorii* as the only crimsonwing on the mountain (Cordeiro 1994, Dulle *et al.* 2016); the record by NJC of a pair of *C. reichenovii* on the west slope above Ngare Nairobi (Cordeiro 1994) and repeated by Keith (2004), must be rejected as no male (with its diagnostic red lores) was observed clearly at the time.

C. salvadorii occurs (R. E. Moreau specimens in NHMUK; Appendix) on Kitumbeine, Longido, Monduli and Essimngor, the four forested mountains nearest to Mt. Meru and Mt. Kilimanjaro (Fig. 1). It is also present on Mt. Oldeani, the highest forested peak in the Crater Highlands (Moreau & Sclater 1938) (Fig. 1). North of the latter, *C. salvadorii* occurs in Loliondo (Selempo 1994) and Ol Doinyo Orok at 1,800 m on the Kenyan side of the border, near Longido (Bennun *et al.* 1986) (Fig. 1).

C. reichenovii appears to be the more widespread crimsonwing species in the Crater Highlands and forests to the south along the Gregory Rift. There are records of this species from Nou and Marang Forests (Moreau & Sclater 1938, Elliott & Fuggles-Couchman 1948; also two specimens in ZMUC from Marang Forest at 1,600 and 1,850 m; Fjeldså 2015) and more generally, the Crater Highlands (Elliott & Fuggles-Couchman 1948) (Fig. 1). Of interest, there is also a specimen of *C. salvadorii* from Nou Forest (leg. J. Kiure, 19 April 2004, ZMUC: Fjeldså 2015). Records of *C. salvadorii* from Nou Forest at a higher elevation of 2,400 m (Fjeldså 2015; Appendix) and of *C. reichenovii* at c.1,950–2,100 m (Moreau & Sclater 1938; Appendix), represent the only currently known Tanzanian location where both species of crimsonwing are found (Fig. 1). Whether they co-occur at similar elevations in Nou Forest is unknown.

Of particular interest, these two species co-occur on four different Albertine Rift mountains. Four *Cryptospiza* species inhabit the Ugandan side of the Ruwenzori Mountains (Willard *et al.* 1998). *C. reichenovii* was found at the lowest elevations (1,960 m) and *C. salvadorii* at 2,700 m, but neither species was found at 2,075 m (Willard *et al.* 1998). On the other hand, Dusky Crimsonwing *C. jacksoni* and Shelley's Crimsonwing *C. shelleyi* overlapped with their congeners, at 1,960–2,700 m and 1,960–3,400 m, respectively. Another study in the Ruwenzori Mountains, Uganda, recorded *C. jacksoni* (1,800–2,700 m), *C. shelleyi* (2,100–3,000 m), and of the two species we focus on, *C. reichenovii* occurred at 1,800 and 2,400 m, with an unresolved identification of *C. salvadorii* / *C. reichenovii* at 2,100 m (Dehn & Christiansen 2001). In the Itombwe Massif, Democratic Republic of Congo, Prigogine (1980) similarly recorded no overlap in elevational ranges among *C. reichenovii* (1,590–1,850 m), *C. shelleyi* (1,890–2,050 m) and *C. salvadorii* (\pm 2,530 m). In the Nyungwe Mountains, Rwanda, where all four *Cryptospiza* occur, the overall ranges overlapped for *C. reichenovii* (1,700–2,500 m) and *C. salvadorii* (1,750–2,350 m), especially in the Bururi Valley (Dowsett-Lemaire 1990). Finally, Turner (in prep.) reports *C. reichenovii* and *C. salvadorii* as sympatric at 2,150–2,450 m in Bwindi-Impenetrable National Park, Uganda. In summary, the evidence of altitudinal range overlap between *C. reichenovii* and *C. salvadorii*, when they co-occur on the same mountain, is probable in the Ruwenzoris, but only definite on two of the four Albertine Rift mountains.

Do both *Cryptospiza* species occur in the Uluguru?

Lack of definitive evidence of altitudinal overlap between *C. reichenovii* and *C. salvadorii* in their entire Tanzanian range has an important bearing on the report of both species co-occurring 400 km south of Mt. Kilimanjaro, in the Uluguru Mountains, Tanzania (Friedmann & Loveridge 1937, Friedmann & Stager 1964). Svendsen & Hansen (1996)

noted that *C. reichenovii* occurs at 900–2,520 m in the Uluguru. The supposed Uluguru record of *C. salvadorii* in Friedmann & Loveridge (1937) involved a female collected by A. Loveridge at Mbeta (probably = Mgeta at c.1,100 m) in the Uluguru Mountains on 24 July 1922. Friedmann was unable to assign this bird to any known subspecies (Friedmann & Loveridge 1937). His comments on this specimen, which is at MCZ, were as follows:

'This single specimen is obviously *C. salvadorii* and not *C. reichenowi*, but it does not fit any of the races of the former. Sclater [Sclater 1930] does not record the species from Tanganyika Territory at all, but Shelley [Shelley 1905] notes that, '. . . in its most southern range the species has been met with by Dr. Stuhlmann at Uluguru.'

'The bird is darker below than *ruwenzori* [= *C. salvadorii ruwenzori*], but is olive-green, not brown as in the Nyasaland form *australis* [= *C. reichenovii australis* following Mackworth-Praed & Grant 1955]. It may belong to a hitherto unknown race intermediate between these two, but more material is needed to make certain of this. For the present the bird may best be designated as above, and its absolute determination left for a more propitious occasion.

'The bird is in fairly fresh plumage; the amount of red on the lower back is intermediate between *borealis* [= *C. s. salvadorii* following Grant & Mackworth-Praed 1945] and *ruwenzori*; the crown is dusker olive-green than in most specimens of either of these. The wing is short, only 50 mm, as against 55–56 mm in females of *ruwenzori* and 56 mm in *borealis*.' (Friedmann & Loveridge 1937: 375)

First, it is important to note that in Friedmann's statement quoted above ('Sclater [Sclater 1930] does not record the species from Tanganyika Territory'), Moreau (1938) corrected Sclater's error that *C. salvadorii* did not occur in Tanzania, as Sclater had previously described *C. s. kilimensis* from Mt. Kilimanjaro in 1934. Franz Stuhlmann, referred to by Shelley (1905), collected plants during 1894–95 in the Uluguru Mountains (Polhill & Polhill 2015), but he also collected bird specimens, some of which were described by Reichenow (1895, 1904). Reichenow's (1895) first mention of the crimsonwing collected by Stuhlmann, presumably from the Uluguru, was listed as '*Cryptospiza salvadorii*'. Further descriptions followed in his tome on African birds, where *C. reichenovii* is considered mostly a species of western Africa with an additional distribution near Lake Victoria, and *C. salvadorii* considered to range across the mountains of eastern Africa (Reichenow 1904: 174). Reichenow mentioned the Stuhlmann specimen from the eastern Uluguru, and for *C. salvadorii* stated more generally ['es bedarf fernerer untersuchung, ob *C. australis* von *C. salvadorii* zu sondern ist'] that this taxon 'also requires further investigation on whether or not it is *C. australis* [now = *C. reichenovii australis*] or *C. salvadorii*', but listed localities from Kenya, Tanzania and Malawi for *C. salvadorii*, with Malawi records under *C. australis*. The Stuhlmann specimen at the Museum für Naturkunde (ZMB 2000/20225), Berlin, was identified as *C. reichenovii australis* (Fig. 2), and we conclude that Reichenow was correct in assigning this specimen to '*C. australis*' and stating that more work was needed to resolve the identification of his grouping.

In addition to the early Stuhlmann record of a putative *C. salvadorii* in the Uluguru (Reichenow 1904, Friedmann & Loveridge 1937, Friedmann & Stager 1964), there is also Loveridge's record of this species from there some years later (Friedmann & Loveridge 1937). Loveridge's specimens were examined at MCZ and two were subsequently sent on loan from MCZ, and compared to a series of *C. reichenovii* and *C. salvadorii* from Kenya and Tanzania at FMNH. There are four Loveridge *Cryptospiza* specimens collected in the Uluguru (Appendix), all of which were mentioned by Friedmann & Loveridge (1937). One (MCZ 134085) has long been considered *C. salvadorii*, and the other three (MCZ 134082, 134083, 134084) were identified as *C. reichenovii* in the same paper.



Figure 2. The female *Cryptospiza* specimen collected by F. Stuhlmann in October 1894 at 2,500 m in the Uluguru Mountains, Tanzania, initially identified as Abyssinian Crimsonwing *C. salvadorii* (presumably by A. Reichenow) and now correctly identified as Red-faced Crimsonwing *C. reichenovii australis*, Museum für Naturkunde, Berlin (© S. Frahnert)

Birds of Africa (Keith 2004) reported the ranges of wing and tail measurements, respectively, for females of *C. salvadorii kilimensis* (wing 56–58 mm, mean = 57.0 mm; tail 40–44 mm, mean = 41.9 mm) and *C. r. reichenovii* (wing 52–57 mm, mean = 53.9 mm; tail 36–41 mm, mean = 39.4 mm). As such data were not provided for *C. r. australis*, the race in the Eastern Arc Mountains to Malawi and Mozambique (Britton 1980, Keith 2004), we measured seven females of *C. r. australis* from Malawi, Mozambique and the Uluguru Mountains from the FMNH series. One Uluguru adult female (MCZ 134084) measured 54 and 39 mm for wing and tail, whereas the juvenile female (MCZ 134085) correspondingly measured 50 and 41 mm, respectively. Wing and tail measurements of *C. r. australis* were 52–56 (mean = 54.9) and 36–40 (mean = 39.2) mm, respectively. Comparing these measurements places the adult MCZ specimen within the range of *C. reichenovii* rather than *C. salvadorii*.

Data from the original labels of the MCZ *Cryptospiza* specimens collected by A. Loveridge from the Uluguru Mountains further clarified the anomalies leading to the misidentification of this taxon as *C. salvadorii*. The identification of *C. salvadorii* was based on the immature specimen (MCZ 134085; collected 24 July 1922) (Friedmann & Loveridge 1937). Differentiation of juveniles and immatures of the two species is difficult (Clement 1993, Stevenson & Fanshawe 2002). Friedmann & Loveridge (1937) were probably unaware that they based their identification on a juvenile, but made no comparisons with six other specimens of *C. reichenovii*, collected by A. Loveridge at Bagilo, in the Uluguru Mountains (Friedmann 1928, Friedmann & Loveridge 1937).

Plumage comparisons of the adult MCZ specimen with a series of females of *C. salvadorii kilimensis* and *C. reichenovii australis* also revealed that the MCZ specimen is more olive on the breast and chest, as well as the head, back and mantle, giving it a slightly darker appearance consistent with *C. reichenovii* (Fig. 3). In contrast, the overall tones of female *C. salvadorii kilimensis* are greyer on the mantle and back, and paler grey-tan on the breast (Fig. 3). In contrast to adult plumage, the immature MCZ specimen more closely matches juvenile *C. r. australis*, but the richer browner coloration and less red on back and mantle is not 100% distinguishable from immature *C. s. kilimensis* (Fig. 4).



Figure 3. Comparative dorsal (top) and ventral (bottom) views of female Red-faced Crimsonwing *Cryptospiza reichenovii australis* and Abyssinian Crimsonwing *C. salvadorii kilimensis*, including the Loveridge specimen from the Uluguru Mountains. Specimens (left to right) as follows: *C. r. australis* (Bagilo, Uluguru Mountains, Tanzania, leg. A. Loveridge, 5 May 1922, MCZ 134084); *C. r. australis* (Bunduki, Uluguru Mountains, Tanzania, leg. J. G. Williams, 6 November 1948, FMNH 188139); *C. r. australis* (Nyika Plateau, Malawi, leg. N. Goswami, 12 November 2009, FMNH 468432); *C. s. kilimensis* (Engare Nairobi, Mt. Kilimanjaro, Tanzania, leg. R. E. Moreau, 12 February 1938, FMNH 203748); *C. s. kilimensis* (near Limuru, Kenya, leg. J. G. Williams, 18 July 1950, FMNH 103503); *C. s. kilimensis* (Chyulu Hills, Kenya, leg. unknown, 29 June 1938, FMNH 103500); *C. s. kilimensis* (Chyulu Hills, Kenya, leg. unknown, 1 June 1938, FMNH 103498) (N. J. Cordeiro)



Figure 4. Comparative dorsal (top) and ventral (bottom) views of juvenile / immature specimens of Red-faced Crimsonwing *Cryptospiza reichenovii australis* and Abyssinian Crimsonwing *C. salvadorii* of both sexes, including the Loveridge specimen from the Uluguru Mountains described in Friedmann & Loveridge (1937). Specimens (left to right) as follows: *C. r. australis* (female, 'Mbeta' = Mgeta, Uluguru Mountains, Tanzania, leg. A. Loveridge, 24 July 1922, MCZ 134085); *C. r. australis* (male, Mt. Gorongosa, Mozambique, leg. S. Reddy, 20 August 2011, FMNH 481454); *C. r. australis* (female, Mt. Gorongosa, Mozambique, leg. C. Salema, 15 August 2011, FMNH 481450); *C. r. australis* (male, Dabaga Highlands, Iringa, Tanzania, leg. J. G. Williams, 26 March 1952, FMNH 217021); *C. salvadorii ruwenzori* (female, Nairobi, Kikuyu, Kenya, leg. V. G. L. van Someren, 24 May 1918, FMNH 203742) (N. J. Cordeiro)

It would be surprising if *C. salvadorii* occurs in the Ulugurus and Mt. Kilimanjaro and not in intervening Eastern Arc montane forests (North and South Pare, West and East Usambara, Nguu, Nguru and Ukaguru: Fig. 1) where, instead, *C. reichenovii* is present (Fjeldså *et al.* 2010). However, the Lukwangule Plateau in the southern portion of the Ulugurus rises to 2,630 m, higher than any mountain further north in the Eastern Arc. It is also noteworthy that Brown Woodland Warbler *Phylloscopus umbrovirens* has an overall similar distribution to *C. salvadorii* with an isolated population on the Lukwangule Plateau (Britton 1980, Urban *et al.* 1997). This perhaps added some weight to accepting the possibility of a similar disjunct distribution of *C. salvadorii* in the southern Ulugurus. Considerable ornithological research and collecting has been done in the Eastern Arc Mountains since the 1930s (Fjeldså *et al.* 2010), but there have been no records of *C. salvadorii*. C. Werema mist-netted birds throughout the Ulugurus and only recorded *C. reichenovii* (Werema 2016, Werema & Howell 2016). The Lukwangule Plateau represents the only possible location where *C. salvadorii* might be found in the Eastern Arc based on elevation. However, specimens of two males and one female collected there by Moreau at 2,150 m are *C. reichenovii* (all at NMHUK; Appendix). Two sight records of putative *C. salvadorii* were claimed for the Ulugurus in October 1993 (Svendsen & Hansen 1996). Both were singles outside of the forest, at 1,430 m near Ukwama, and at 1,600 m at Tchenzema (Svendsen & Hansen 1996; see Fig. 1), in habitat and at elevations consistent with *C. reichenovii* (Britton 1980). The authors stated ‘the birds were seen under good conditions, the Tchenzema bird being observed for 5 minutes at only 10 m distance’, but they provided no details of the sex or age of the birds in either observation.

Both *Cryptospiza* species discussed here occur as pairs, and our collective observations suggest that vagrant singles are mostly immatures. Following our examination of specimens, we conclude that all of the specimens and observations claimed as *C. salvadorii* from the Uluguru Mountains were misidentified *C. reichenovii*, as follows: (i) F. Stuhlmann’s first *Cryptospiza* specimen from 1894 was indeed *C. reichenovii*; (ii) the previous identification of Loveridge’s Uluguru immature *Cryptospiza* specimen as *C. salvadorii* can be rejected; (iii) the identification of another of Loveridge’s specimens from the same mountain and in the same year as *C. reichenovii* is confirmed; (iv) all other dated crimsonwing records, including a more recent collecting expedition (Friedmann & Stager 1964), and all other known specimens from the Uluguru Mountains in the museum collections we studied can be identified as *C. reichenovii*; and (v) the only definitive record of the two species co-occurring in Tanzania is from Nou Forest, although overlap in elevation is apparent elsewhere where both species co-occur (i.e. at least two of four Albertine Rift mountains).

Therefore, with no other records of *C. salvadorii* from the Ulugurus, including during the intensive mist-net sampling by C. Werema, we reject the identification of the two sight records in 1993 (Svendsen & Hansen 1996) as *C. salvadorii*. We surmise that Stuart & Jensen (1985) were the first to correctly treat early reports of *C. salvadorii* in the Ulugurus as probably misidentified *C. reichenovii*, but despite their concern, until now, no one investigated this claim. Unless a specimen or definitive photograph is obtained that proves otherwise, we conclude that *C. reichenovii* alone occurs in the Uluguru Mountains, Tanzania.

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References:

- Beesley, J. S. 1972. Birds of the Arusha National Park, Tanzania. *J. E. Afr. Nat. Hist. Soc.* 132: 1–30.
- Bennun, L. A., Gichuki, C., Darlington, J. & Ngweno, F. 1986. The avifauna of Ol Doinyo Orok, a forest island: initial findings. *Scopus* 10: 83–86.
- Britton, P. L. (ed.) 1980. *Birds of East Africa*. E. Afr. Nat. Hist. Soc., Nairobi.
- Clement, P. 1993. *Finches and sparrows*. Christopher Helm, London.
- Cordeiro, N. J. 1994. Forest birds on Mt Kilimanjaro, Tanzania. *Scopus* 17: 65–112.
- Dehn, L. & Christiansen, M. 2001. Altitudinal distributions of congeneric montane forest bird species along an elevational gradient in the Ruwenzori Mountains National Park, western Uganda. *Scopus* 22: 29–35.
- Dowsett-Lemaire, F. 1990. Eco-ethology, distribution and status of Nyungwe Forest birds (Rwanda). Pp. 31–85 in Dowsett, R. J. (ed.) *Enquête faunistique et floristique dans la forêt de Nyungwe, Rwanda. Tauraco Res. Rep.* 3. Tauraco Press, Liège.
- Dulle, H. I., Ferger, S. W., Cordeiro, N. J., Howell, K. M., Schleuning, M., Böhning-Gaese, K. & Hof, C. 2016. Changes in abundances of forest understorey birds on Africa's highest mountain suggest subtle effects of climate change. *Divers. Distrib.* 22: 288–299.
- Elliott, H. F. I. & Fuggles-Couchman, N. R. 1948. An ecological survey of the birds of the Crater Highlands and Rift Lakes, northern Tanganyika territory. *Ibis* 90: 394–425.
- Fjeldsã, J. 2015. Aves Tanzanian collection at the Natural History Museum of Denmark (SNM). Zoological Museum, Natural History Museum of Denmark. <https://doi.org/10.15468/xebbf5>.
- Fjeldsã, J., Kiure, J., Doggart, N., Hansen, L. A. & Perkin, A. 2010. Distribution of highland forest birds across a potential dispersal barrier in the Eastern Arc Mountains of Tanzania. *Steenstrupia* 32: 1–43.
- Friedmann, H. 1928. A collection of birds from the Uluguru and the Usambara Mountains, Tanganyika Territory. *Ibis* 70: 74–99.
- Friedmann, H. & Loveridge, A. 1937. Notes on the ornithology of tropical East Africa. *Bull. Mus. Comp. Zool.* 81: 1–413.
- Friedmann, H. & Stager, K. E. 1964. Results of the 1964 Cheney Tanganyikan Expedition: ornithology. *Contrib. Sci., Los Angeles Co. Mus.* 84: 1–50.
- Grant, C. H. B. & Mackworth-Praed, C. W. 1945. Notes on Eastern African birds. *Bull. Brit. Orn. Cl.* 66: 7–9.
- Hall, B. P. & Moreau, R. E. 1970. *An atlas of speciation in African passerine birds*. Trustees of the Brit. Mus. (Nat. Hist.), London.
- Keith, S. 2004. *Cryptospiza*. Pp. 278–285 in Fry, C. H. & Keith, S. (eds.) *The birds of Africa*, vol. 7. Christopher Helm, London.
- Mackworth-Praed, C. W. & Grant, C. H. B. 1955. *African handbook of birds: birds of eastern and north eastern Africa*, vol. 2. First edn. Longmans Green & Co., London.
- Mackworth-Praed, C. W. & Grant, C. H. B. 1960. *African handbook of birds: birds of eastern and north eastern Africa*, vol. 2. Second edn. Longmans Green & Co., London.
- Moreau R. E. 1938. Birds of the Childs-Frick Expedition. *Ibis* 80: 591–597.
- Moreau, R. E. & Sclater, W. L. 1935. A contribution to the ornithology of Kilimanjaro and Mount Meru. *Proc. Zool. Soc. Lond.* 1935: 843–890.
- Moreau, R. E. & Sclater, W. L. 1937. The avifauna of the mountains along the Rift Valley in north central Tanganyika territory (Mbulu District).—Part I. *Ibis* 79: 760–786.
- Moreau, R. E. & Sclater, W. L. 1938. The avifauna of the mountains along the Rift Valley in north central Tanganyika territory (Mbulu District).—Part 2. *Ibis* 80: 1–32.
- Payne, R. B. 2010. Family Estrildidae (waxbills). Pp. 234–277 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 15. Lynx Edicions, Barcelona.
- Polhill, D. & Polhill, R. M. 2015. *East African plant collectors*. Kew Publishing, Kew.
- Prigogine, A. 1980. The altitudinal distribution of the avifauna in the Itombwe forest (Zaire). Pp. 169–184 in *Proc. IV Pan-Afr. Orn. Congr.* Southern Afr. Orn. Soc., Johannesburg.
- QGIS Development Team. 2019. QGIS Geographic Information System. Open Source Geospatial Foundation Project. <http://qgis.osgeo.org>.
- Reichenow, A. 1895. Dr. Stuhlmann's neueste Forschungen in Ost-Afrika. *Orn. Monatsb.* 3: 87.
- Reichenow, A. 1904. *Die Vögel Afrikas*, Bd. 3. J. Neumann, Neudamm.
- Sclater, W. L. 1930. *Systema avium Æthiopicarum*, pt. 2. British Ornithologists Union, London.
- Selempo, E. 1994. Birds recorded from the Loliondo area of northern Tanzania. *Scopus* 17: 124–128.
- Shelley, G. E. 1905. *The birds of Africa, comprising all the species which occur in the Ethiopian Region*, vol. 4. R. H. Porter, London.
- Short, L. L., Horne, J. F. M. & Muringo-Gichuki, C. 1990. Annotated check-list of the birds of East Africa. *Proc. West. Found. Vert. Zool.* 4: 61–246.

- Sjöstedt, Y. 1908. Vögel. Pp 1–184 in Sjöstedt, Y. (ed.) *Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition nach dem Kilimandjaro, dem Meru und den umgebenden Massaiesteppen Deutsch-Ostafrikas, 1905–1906*. Almqvist & Wiksells, Stockholm.
- Stevenson, T. & Fanshawe, J. 2002. *Field guide to the birds of East Africa*. T. & A. D. Poyser, London.
- Stuart, S. N. & Jensen, F. P. 1985. The avifauna of the Uluguru [= Uluguru] Mountains, Tanzania. *Gerfaut* 75: 155–197.
- Svendsen, J. O. & Hansen, L. A. 1996. Report on the Uluguru biodiversity survey 1993. Royal Society for the Protection of Birds, Danish Centre for Tropical Biodiversity & Tanzania Forestry Research Institute.
- Turner, D. A. in prep. *The birds of East Africa: their classification, taxonomy, status and distribution*.
- Urban, E. K., Fry, C. H. & Keith, S. (eds.) 1997. *The birds of Africa*, vol. 5. Academic Press, London.
- Werema, C. 2016. Seasonal variation in understorey bird species diversity and abundance in the Uluguru Nature Reserve, Tanzania. *Afr. J. Ecol.* 54: 299–307.
- Werema, C. & Howell, K. M. 2016. Seasonal variation in diversity and abundance of understorey birds in Bunduki Forest Reserve, Tanzania: evaluating the conservation value of a plantation forest. *Ostrich* 87: 89–93.
- White, C. M. N. 1963. *A revised check list of African flycatchers, tits, tree creepers, sunbirds, white-eyes, honey eaters, buntings, finches, weavers and waxbills*. Govt. Printer, Lusaka.
- Willard, D. E., Gnoske, T. P. & Kityo, R. M. 1998. An elevational survey of the birds of the Mbukuku and Bujuku River valleys, Rwenzori Mountains, Uganda. Pp. 172–179 in Osmaston, H., Tukahirwa, J., Basalirwa, C. & Nyakama, J. (eds.) *The Rwenzori Mountains National Park: Uganda exploration, environment, conservation, management and community relations*. Makerere Univ. Press, Kampala.
- Zimmerman, D. A., Turner, D. A. & Pearson, D. J. 1996. *Birds of Kenya and northern Tanzania*. Princeton Univ. Press.

Addresses: Norbert J. Cordeiro, Dept. of Biology (mc814WB), Roosevelt University, 430 S. Michigan Avenue, Chicago, IL 60605, USA; and Integrated Research Center, The Field Museum, 1400 South Lake Shore Drive, Chicago, IL 60605-2496, USA, e-mail: ncordeiro@fieldmuseum.org. David C. Moyer, Integrated Research Center, The Field Museum, 1400 South Lake Shore Drive, Chicago, IL 60605-2496, USA; and P.O. Box 691, Iringa, Tanzania. Simon N. Stuart, Synchronicity Earth c/o Biocensus, The Malthouse, 17–20 Sydney Buildings, Bath, BA2 6BZ, UK, e-mail: simon@synchronicityearth.org. John M. Bates, Science & Education, The Field Museum, 1400 South Lake Shore Drive, Chicago, IL 60605-2496, USA, e-mail: jrbates@fieldmuseum.org. Donald A. Turner, P.O. Box 1651, Naivasha 20117, Kenya, e-mail: don@originsafaris.info

Appendix

List of all specimens consulted for this study (locality, museum acronym, registration number, sex, and collector). Refer to Fig. 1 for localities and to Methods for museum acronyms.

Abyssinian Crimsonwing *Cryptospiza salvadorii*

Mt. Kilimanjaro, Ngare Nairobi: NHMUK 1934.6.18.61 (m), 1934.6.18.62 (m), leg. R. E. Moreau; Mandara: NHMUK 1934.6.18.63 (m), 1934.6.18.64 (f), leg. R. E. Moreau.

Mt. Meru, Ngare Olmotoni: NHMUK 1939.6.19.274 (m), 1939.6.19.224 (m), leg. R. E. Moreau; unspecified location: FMNH 484698 (sex not recorded), leg. M. Munissi; near Momela: YPM 96397 (f), leg. G. Heinrich.

Oldeani, Crater Highlands: NHMUK 1935.12.25.330 (m), 1935.12.25.331 (m), 1935.12.25.332 (m), leg. R. E. Moreau.

Essimngor, northern Tanzania: NHMUK 1935.12.25.333 (m), leg. R. E. Moreau; 1938.3.13.35 (sex unknown, juv), leg. E. G. Rowe.

Ketumbeine, northern Tanzania: NHMUK 1937.6.22.203 (f), 1937.6.22.204 (f), 1937.6.22.205 (f), 1937.6.22.206 (f), 1937.6.22.209 (f), leg. R. E. Moreau.

Monduli, northern Tanzania: NHMUK 1937.6.22.207 (f), leg. R. E. Moreau.

Longido, northern Tanzania: NHMUK 1937.6.22.208 (f), 1937.6.22.210 (m), leg. R. E. Moreau.

Nou Forest, Crater Highlands (ZMUC 094982), leg. J. Kiure.

Red-faced Crimsonwing *Cryptospiza reichenovii*

Nou Forest, Crater Highlands: NHMUK 1935.12.25.322 (f), 1935.12.23.323 (f), 1935.12.25.324 (m), 1935.12.25.325 (f), 1935.12.23.326 (f), 1935.12.25.327 (f), 1935.12.25.329 (f), leg. R. E. Moreau.

Uluguru Mountains, Lukwangule Plateau: NHMUK 1937.12.27.334 (m), 1937.12.27.335 (m), 1937.12.27.337 (f), leg. R. E. Moreau; location not specified: MCZ 134082 (m), MCZ 134083 (f), leg. A. Loveridge; location not specified: ZMB 2000/20225 (f), leg. F. Stuhlmann; Bagilo: MCZ 134084 (f), leg. A. Loveridge; Mgeta: MCZ 134085 (f), leg. A. Loveridge.